

BELLCOMM, INC.

SUBJECT: Description of the S-IC Stage
Structure - Case 330

DATE: February 2, 1967

FROM: S. H. Levine

ABSTRACT

The purpose of this memorandum is to provide a description of the S-IC stage structure in sufficient detail such that the user of this information can be better equipped to judge the impact of changes to these areas as they occur in the program.

This information is in essence a compendium of data and drawings compiled from various Boeing Company and MSFC documentation which includes design requirements documents, manufacturing plans, end item specifications and other data sources.

(NASA-CR-153761) DESCRIPTION OF THE S-IC
STAGE STRUCTURE (Bellcomm, Inc.) 29 p

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(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

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MEMORANDUM FOR FILE

PURPOSE

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GENERAL

The S-IC stage is composed of five principal assemblies, namely, the Forward Skirt (Unit 120), the Oxidizer Tank (Unit 119), the Intertank (Unit 118), the Fuel Tank (Unit 117) and the Tail or Thrust Section (Unit 115). Figures 1 through 4 are presented to illustrate the general composition, the physical dimensions and some other general characteristics of the S-IC stage.

Forward Skirt Structure (Figures 5 and 6)

The forward skirt is an unpressurized semi-monocoque cylindrical structure approximately 10 feet long and 33 feet in diameter. This structure is composed of three internally located Circumferential Support Rings upon which are mounted 12 Skin Panel Assemblies.

The Circumferential Support Rings (3) are constructed of 7079 aluminum alloy and are made up of six segments joined together in a circular form. The purpose of these rings is to maintain the circular shape of the forward skirt. The topmost ring, the Interface Ring, an inverted L shaped cross sectioned unit, provides the S-IC structural interface at which the S-II aft interstage is physically spliced to the S-IC Forward Skirt (at vehicle station 1541.0 inches). Two-hundred sixteen - 1/2 inch diameter holes drilled on a 394.340 inch diameter circle provide the mechanics for bolting the S-II stage to the S-IC.* The center ring is called the Channel Ring and is approximately 7.5 inches across the web. The bottom-most ring has a J shaped cross section and is appropriately called the J Ring.

*Crowe, T. H. - "Description of S-II Stage Structures" -
Memorandum for File

The Skin Panel Assembly is composed of a lower section (below the Channel Ring) which is cylindrical in form and an upper section which is an inverted truncated cone having a slope of $0^{\circ}36'$. The 12 skin panels forming the Skin Panel Assembly are reinforced by 216 external hat-shaped stringers which are spaced on 5-3/4 inch centers and span the full length of the skirt. These stringers transmit the stage longitudinal loads to the S-II stage via the Interface Ring. The skin panel assembly is made up entirely of 7075-T6 aluminum alloy.

Provision is made for mounting S-IC Telemetry Equipment, Range Safety System Equipment, ODOP System Equipment, the LOX tank pressurization tunnel and the electrical cable tunnel in and on the Forward Skirt. In addition, the Forward Skirt has provisions for the GOX to ground system interface, the oxidizer tank vent to ground interface, a service access hatch and the S-IC forward umbilical plate (interface with S-IC Forward Umbilical Tower Service Arm #1 at LUT elevation 60 ft and located 73° from vehicle position I towards position II).

Oxidizer Tank Structure (Figure 7)

The oxidizer tank is a 64 foot assembly having a capacity of 345,000 gallons, and is constructed of 2219-T87 weldable aluminum alloy. This assembly consists of a 396 in diameter cylindrical central assembly capped and welded at both ends by means of Y shaped rings (one upper and one lower ring) to convex ellipsoidal bulkheads.

The Cylindrical Skin Section Ring Assembly is a semimonocoque structure which consists of 4 - 10 ft high skin panel rings which are welded together circumferentially.

Each skin panel ring is in turn made up of 4 welded panels which are approximately 10 feet high by 26 feet long. The entire assembly's general skin thickness varies from .185 inches at the top to .254 inches at the bottom. T shaped 2 inch high vertical stringers spaced on 7.4 inch centers are integrally milled over the full length of the inside of this assembly. The cylindrical section of the oxidizer tank forms the outside skin of the S-IC stage between the Forward Skirt and the Interstage. Fifteen annular anti-slosh baffles constructed of 7079 aluminum alloy are mounted in the cylindrical and bulkhead sections of the LOX Tank. The 13 baffles which are mounted in the cylindrical section measure .040 inches thick x 33 feet O.D. x 28 feet I. D. The 2 cantilever baffles located in the bulkheads are slightly smaller in diameter. In addition to preventing slosh, these baffles supported by aluminum tubing also assist in stabilizing the tank structure.

Mounted internal to the cylindrical skin section assembly and fastened to the annular baffles are four Helium Pressurization bottles (3200 psia) which are constructed of 2014-T6 aluminum and are approximately 2 feet in diameter by 18 feet long. These units are mounted symmetrically about vehicle position I and provide for pressurization of the fuel tank during flight.

The Y Rings which join the bulkheads to the Cylindrical Skin Section Ring Assembly also form the mechanical joints between the LOX Tank and both the Forward Skirt and the Intertank Structure.

The LOX Tank Bulkheads (forward and aft) conform to an ellipsoidal major axis to minor axis ratio of $\sqrt{2}$ and each are assembled by welding eight apex gore sections to eight base gore sections. Gore sections are milled from 1 inch thick 2219-T87 aluminum alloy material to thicknesses of from .121 inches to .270 inches. The Forward Bulkhead contains a GOX Distributor of stainless steel and aluminum construction which is mounted at the centerline of the LOX Tank and at the apex of the forward bulkhead. This unit distributes GOX from engine heat exchangers (located in the Thrust Structure) to the LOX Tank for pressurization. The forward bulkhead also contains provisions for a LOX vent valve, a LOX vent and a relief valve and 2 - 18 inch diameter manholes (located at vehicle position II and IV). The Aft Bulkhead contains a cruciform baffle assembly constructed of 7079 aluminum alloy which is used to suppress LOX sloshing and vortexing. Provisions are made for LOX fill and drain lines and associated hardware between vehicle positions I and II (normal draining of the LOX Tank uses equipment common to the fill system). An emergency LOX drain line located between vehicle positions III and IV is used for static test operations only. The LOX Tank Aft Bulkhead also contains provisions for attaching 5 - 20 inch diameter LOX suction lines (1 per engine) to the Thrust Structure. These suction lines are covered by and enclosed in LOX tunnel assemblies which will be discussed later on in this memorandum. Screens and anti-vortex devices are provided at LOX line inlets.

Intertank Structure (Figure 8)

The Intertank Structure is an unpressurized semi-monoque cylindrical structure approximately 22 feet long by 33 feet in diameter and constructed of 7075-T6 aluminum alloy components. Consisting of 18 vertical corrugated skin panels arranged in cylindrical form and varying in skin thickness from .160 to .185 inches, the Intertank Structure separates the LOX Tank from the Fuel Tank. Fittings are provided at the forward and aft ends of the skin panels which provide for the mechanical mating of the Intertank Structure to Y Rings located on the Fuel and LOX Tank.

There are five Ring Frames constructed of I beams having web planes perpendicular to the longitudinal axis of the launch vehicle and spaced on 49.5 inch centers which maintain the circular shape and provide stability to the skin panels of the Intertank.

Openings and hatches are provided in the Intertank skin for personnel access, for two static test fuel vent lines and for one flight vent line. In addition, provisions are made for one static test fuel pressurization line, one flight fuel pressurization line, a LOX emergency drain valve line and its pneumatic control line, and finally the LOX fill and replenishment umbilical (located at station 785.15 and 73° from vehicle position I towards vehicle position II). The LOX fill and replenishment umbilical interfaces with the S-IC Intertank Umbilical Tower Service Arm on the LUT.

Fuel Tank Structure (Figure 9)

The 216,000 gallon Fuel Tank structure is approximately 43 feet long and 33 feet in diameter and is constructed similar to the LOX tank. The entire fuel tank shell, consisting of a cylindrical section assembly enclosed on both ends by two convex ellipsoidal bulkheads, is manufactured of 2219-T87 welded aluminum alloy. Bulkheads are joined to the cylindrical section by welds at Y Rings located at the top and bottom of the assembled cylinder.

The Cylindrical Skin Section Assembly consists of two cylindrical sections welded together. Four skin panels joined in cylindrical form make-up each skin section. Each panel is approximately 10 feet high by 26 feet long. 51 - 2 inch high vertical T shaped stringers are integrally milled on the inside surface of each skin panel and are spaced on 6.10 inch centers. These stringers provide stiffness to the structure and transmit loads from the Thrust Structure to the Intertank. The skin thickness of the assembly generally varies from .170 to .193 inches, forward to aft. This section of the Fuel Tank forms the outer surface of the S-IC Stage between the Interstage and the Thrust Structure.

There are 9 annular anti-slosh baffles constructed of aluminum alloy, seven of which are mechanically attached to the T stiffeners on the interior surface of the cylindrical section of the fuel tank and two of which are cantilevered from the inner surface of the bulkheads (one baffle per bulkhead). The annular baffles are generally .040 inches thick x 33 feet O.D. x 28 feet I.D., however, the cantilever baffles are slightly smaller in size. Rigid tubing is provided for additional support of these baffles.

The Y Rings (2) which join the bulkheads to the Cylindrical Skin Section Assembly also provide the mechanical joint which unites the Fuel Tank to the Intertank Structure and the Thrust Structure. Holes are located in the Upper Y Ring to permit drainage of the Intertank area.

The Fuel Tank Bulkheads (forward and aft) conform to an ellipsoidal major axis to minor axis ratio of $\sqrt{2}$ and each are assembled by welding eight apex gore sections to eight base gore sections (Figure 7).

Five LOX Tunnel Assemblies are 22 inches in diameter and carry the five 20 inch diameter LOX suction lines from the aft bulkhead of the LOX tank through both Fuel Tank bulkheads to the Thrust Structure area of the S-IC Stage. LOX lines (5) are reduced to 17 inches in diameter at tunnel outlets in the Thrust Structure area. Stiffener rings are provided around the tunnels for structural rigidity. In addition to providing support for the LOX suction lines the LOX Tunnels provide Fuel Tank insulation from these cryogenic fluid lines and visa versa.

The Upper Bulkhead of the Fuel Tank has five penetrations for LOX tunnels, one slightly off the centerline of the S-IC stage to avoid fuel fittings located in close proximity to the centerline of the dome, and the rest located at 45° intervals from each vehicle position location. LOX tunnels are mechanically linked to the forward dome of the Fuel Tank. Four 18 inch diameter armholes (one at each vehicle position location) are provided in the Upper Bulkhead. One fuel vent valve is mounted to the manhole cover at vehicle position I and two facility vent valves are located on the manhole at vehicle position III. In addition, a removable gaseous helium distributor which distributes gasified helium from the engine heat exchangers to the fuel tank for flight pressurization is provided.

The Aft Bulkhead contains an internally located cruciform baffle constructed of 7075 aluminum alloy and used to minimize vortexing and sloshing in the lower part of the fuel tank. An exclusion riser (essentially a filler of the apex area of the bulkhead) constructed of polyurethane foam material, is located centrally at the lowest part of the bulkhead and is used to prevent entrapment of fuel below the level of the fuel suction line fittings and thereby reduces S-IC Stage unusable fuel. Five 22 inch penetrations are provided in the Aft Bulkhead where the LOX tunnels passing through the Fuel Tank are welded. The Fuel Tank Aft Bulkhead also provides for the attachment of ten-12 inch diameter fuel suction lines

(2 per engine) with screens and anti-vortex devices at fuel suction line inlets to reduce vortexing at these points. In addition, the Aft Bulkhead provides for one 6 inch diameter fill and drain line and associated hardware (normal draining of the fuel tank is conducted using equipment common to the fuel fill system) and for one emergency Fuel Drain Line used only for test stand operations.

Thrust Structure (Figure 10)

The Thrust Structure, the most complex and heaviest of the five major S-IC structural units, is an unpressurized cylindrical semimonocoque structure which is approximately 33 feet in diameter and 19.5 feet long. This portion of the S-IC Stage is designed to support four outboard gimballed F-1 engines on a 364 inch diameter circle and one inboard fixed F-1 engine on the centerline of the launch vehicle. All engines are arranged in the same vehicle station plane. The Thrust Structure functions to symmetrically distribute locally applied engine loads and holddown and support reaction loads to attain uniform symmetrical loading along the Fuel Tank Aft Y Ring (see previous discussion).

The Center Engine Support Assembly (Figure 11) is a crucifix form consisting of four stiffened web assemblies (capped and joined together on top and bottom by tee shaped beam caps and stiffened by vertical and horizontal stiffeners) which are arranged radially along vehicle position lines and mechanically mated at the center to a vertical Center Engine Thrust Post to which is mounted the inboard fixed F-1 Engine. The stiffened webs and caps are constructed of 7178 Aluminum Alloy and are each approximately 3/8 inch thick by 78 inches high by 175 inches long (excluding the beam caps). The Center Engine Thrust Post is constructed of forged 7079 Aluminum Alloy.

There are four Holddown Posts located on the outer periphery of the S-IC Thrust Structure at each vehicle position and mated to the Center Engine Support Assembly. These posts are constructed of a one piece 7079 aluminum alloy forging which is approximately 14 feet high and 11 inches square at the base (not including the flange which ties the Holddown Post to the Thrust Structure Skin) tapering to a smaller cross section at the top. Each Holddown Post is joined at the forward end to an Upper Thrust Ring and at the aft end to a Lower Thrust Ring (to be discussed later). Thrust loads are transmitted from the Center Engine Thrust Post through the radial arms of the Center Engine Support Assembly up through the four Holddown Posts and finally to the Upper Thrust Ring where it is then symmetrically distributed to forward sections of the vehicle.

Holddown Post positions are coincident with the LUT Holddown Arm positions (North, South, East and West) and the vehicle is held and restrained to the launch pad from these points.

Located approximately 45° from Holddown Posts on the outer perimeter of the Thrust Structure are four outboard engine vertical Thrust Posts. The Thrust Posts (Figure 12) are built up box type cross sectional units which are 36 inches by 39 inches at the base (common with the Lower Thrust Ring attach surface) and taper to a 14 inch by 22 inch cross section at the top (the Upper Thrust Ring). These posts, which are the longest lead item of the S-IC stage, are 14 feet high and are constructed entirely of machined 7075-T6 aluminum alloy forgings. Each post is mechanically fastened to the Upper and Lower Thrust Ring as well as to each Intermediate Ring of the Thrust Structure (see discussion below). Outboard gimballed F-1 engines (4) are mated to the thrust posts by means of adapter fittings tied to engine gimbal blocks.

The Upper Thrust Ring is constructed of 7079 Aluminum Alloy and is 30 inches wide and annular in form. This ring consists of a $3/16$ inch thick web plate bridging two circular tee shaped beam caps (one outboard and one inboard) and is reinforced by radial stiffeners.

Intermediate Ring Assemblies (Figure 13) made of 7079 aluminum alloy are smaller in size than either the Upper or Lower Thrust Ring. These rings are spaced approximately 32 inches from each other and are located between the Upper and Lower Thrust Rings. These rings too are made up of web plates which bridge beam caps. The beam caps used for the Intermediate Rings have angle cross sections and while the outboard angle beam cap conforms to the perimeter of the stage, the inboard angle beam cap is linear and connects Thrust Posts to Holddown Posts. Radial support stiffeners are also provided to reinforce these rings. Stiffened intercostal assemblies (32) are located between the upper and lower pairs of Intermediate Rings (16 per pair) for additional support and stability for the Intermediate Rings.

The lower Thrust Ring Assembly is an annular ring constructed of 7079 aluminum alloy and is approximately 40 inches wide. This ring consists of inboard and an outboard tee shaped caps bridged by and mechanically fastened to a $3/8$ inch thick web plate which is reinforced from beneath by radial tee cross sectional stiffeners. The outboard tee shaped beam cap forms the outer surface of the S-IC stage at the location of the Lower Thrust Ring. The Lower Thrust Ring in coordination with the Thrust Posts supports retrorockets (2 per fin location) which are used for separating the S-IC from the S-II.

The Skin Panel Assembly consisting of 16 skin panels spliced together by hat-shaped external skin splices and constructed of 7075-T6 aluminum alloy forms the outside surface of the Thrust Structure from the interface with the Fuel Tank to the Lower Thrust Ring. Approximately 19 feet high and cylindrical in form the Skin Panel Assembly varies in thickness from .210 inches at the forward end to .680 inches at the aft end and is reinforced by mechanically attached external vertical hat-shaped stringers.

Provisions are made for cutouts for a 6 inch diameter drain duct from the inboard LOX suction line (above the pre valve) for a 6 inch diameter fuel fill and drain line and for an emergency fuel drain line (test stand usage only). Three aft life-off umbilical panels exist which are all located at vehicle station 135.75 and umbilicals attached to these panels are retracted upon a vehicle rise of 3.6 inches. These umbilicals interface with the LUT Tail Service Masts and are located as follows: two at $12^{\circ} 39' 22\frac{1}{2}''$ from vehicle position I towards II and one at $12^{\circ} 39' 22\frac{1}{2}''$ from vehicle position III towards IV.

Two aluminum, external, V-shaped tubular appendages to the cylindrical section of the Thrust Structure each linked to the Thrust Structure by an aluminum tube which extends forward and is tied to the Skin Panel Assembly provide a truss arrangement which is used to support the S-IC Flight Control System gimbal servo actuators. These appendages are located on either side and in close proximity to each Engine Thrust Post and are enclosed by Engine Fairings (to be discussed below).

Four Fin and Fairing Assemblies (Figure 14) are located around the periphery of the S-IC Thrust Structure (one at each outboard engine location). Each Engine Fairing consists of a semi-conical shaped structure which has a base diameter of 166.50 inches, is approximately 8 feet deep when mounted on the S-IC Thrust Structure and has a slope of approximately 15° . This structure extends from vehicle station 48.5 to vehicle station 362 (approximately 26 feet long). The engine fairings function to prevent inflight aerodynamic loads from interfering with engine movement, to provide protective cover for F-1 outboard engines, to support aerodynamic fins, to house S-IC retrorockets used in separation (2 per fairing) and to provide protective covering for elements of engine accessories and the S-IC flight control system. The lower 5-1/2 feet of each fairing is constructed of titanium alloy while the rest of the total assembly is manufactured of aluminum alloy. Aluminum and titanium sections are joined at a Fin Spar Attach Frame (see Figure 15).

The forward 12 feet of the Engine Fairing Assembly is considered the Upper Fairing while the lower 14 feet is appropriately called the Lower Fairing. The Fin Spar Attach Frame (previously mentioned) provides the basic structural tie between the cylindrical Thrust Structure and the Fairing and between the aerodynamic fin and the Fairing. The Fin Spar Attach Frame consists of two machined aluminum plates joined at the center by a steel fin spar attach fitting and fixed to the Thrust Structure by steel thrust structure attach fittings at each end. Six link fittings are also provided for attaching the lower fairing to the Thrust Structure Assembly. Four Titanium alloy frame assemblies are provided below the Fin Spar Attach Frame in the Lower Fairing Assembly at intervals of about 1-1/2 feet while three aluminum frames spaced at 2-1/2 foot intervals exist above the Fin Spar Attach Frame. These frames are used for structural stability. The major structural frame of the lower four is the truss frame located 1-1/2 feet from the bottom of the lower fairing. This frame contains a truss consisting of welded hastelloy tubes and plates for structural rigidity. Intercostals are provided between frame units for additional structural support. Closeout channels are fastened to the ends of these frames linking them over the full length of the Lower Fairing. Skin covering the lower fairing is stiffened by longitudinal L shaped external stiffeners. The Upper Fairing, which is removable for access to retrorockets mounted on the Thrust Structure, consists of three frame assemblies, closeout channels, and intercostals similar to the Lower Fairing. Skin reinforced by L shaped external vertical stringers also covers the Upper Fairing Assembly. Air scoops are mounted to the Lower Fairing on early versions of the S-IC (S-IC-1 and 2), however, the need for this thermal control has been eliminated on subsequent vehicles.

Externally attached to each engine fairing at the centerline of the semi-conical structure is a rigid aerodynamic fin assembly (Figure 16) having a sweep back angle of 30 degrees and having a surface area of 75 square feet. Fins have been added to the S-IC stage to provide aerodynamic stability during first stage flight of the Apollo-Saturn Space Vehicle. Fins are identified as follows: Fin A (between vehicle position I and II), Fin B (between vehicle position II and III), etc. Each fin measures approximately 11-1/4 feet high (at the root), and is 15 inches wide at the root and 4 inches wide at the outboard end. External components of the Fin Assembly are constructed of titanium alloy while internal components are made of aluminum alloy. The fin spar which joins the forward section of the fin to the aft section of the fin is the major structural point mechanically tying the fin to the Engine Lower Fairing Assembly

(at the Fin Spar Attach Fitting - see above). There are ten nose ribs, one tip nose rib, and one root nose rib joining the leading edge beam to the spar and forming a leading edge wedge angle of 10° . The aft section of the fin, from the spar to the trailing edge beam is essentially rectangular in cross section and also consists of ten trailing edge ribs, a root trailing edge rib and a tip trailing edge rib. The leading edge beam has a leading edge radius of $1/4$ of an inch and is constructed entirely of titanium alloy as is the trailing edge beam. The Spar Assembly and the Trailing Edge Beam Assembly each are comprised of two chords joined together by a web and stiffeners. The Spar Assembly protrudes from the basic fin profile at the root end where it is bolted to the engine fairing. Skin panels cover the fin rib and spar assemblies and closure angles and bolts splice the skin at the root of the fin to the engine fairing.

MISCELLANEOUS STRUCTURES

1. A base heat shield (Figure 17) consisting of fifty $1/4$ inch panels (at approximately vehicle station 110) is provided forward of the engine gimbal plane which provides thermal protection of critical engine components and base region components during launch and flight. Access panels are provided in each quadrant of the heat shield for servicing the thrust structure and engine areas. The heat shield is constructed of fifteen 7 ph stainless steel open-faced honeycomb and is covered with M-31 insulation. Pads are provided on the thermal shield (bonded in place on the insulation) at vehicle positions II and IV for liftoff switch roller follower interfaces. Flexible curtains are provided for closeout of heat shield gaps at propellant line interfaces.
2. Engine Fairing Heat Shields (4) provide a thermal protective barrier for the innards of the engine fairings. Made up of eight panels each and constructed of the same material as the base heat shield, each fairing heat shield is mounted to the thrust structure in line with the base heat shield and tilted down in a plane at an angle of $7^{\circ} 14'$ where it extends and is joined to and supported by the Fin Spar Attach Frame of the Engine Fairing Assembly.
3. Two tunnel assemblies constructed of aluminum are mounted to the external surface of the S-IC stage. Each is semi-elliptical in cross section (approximately 1 foot x 2 feet) with a hyperbolic fairing at each end and extends from vehicle station 180 in

the Thrust Structure to vehicle station 1538 in the Forward Skirt. The Pressurization Tunnel houses, protects, and supports pressurization lines between the Thrust Structure (location of the F-1 engine heat exchangers) and S-IC stage penetration points at pressurant usage locations (propellant tank domes). This tunnel is located 11° 15' from vehicle position III toward Fin C. The Electrical Tunnel is designed to house, protect and support electrical wiring from the Forward Skirt to the Thrust Structure and pressurization lines from the helium pressurization bottles located in the LOX Tank to the Thrust Structure. This tunnel similar in design to the Pressurization Tunnel is mounted 180° from the pressurization tunnel on the periphery of the S-IC stage. Both tunnels are supported from the S-IC Stage by support fittings spaced at 40 inch intervals in the propellant tank area of the stage and fittings tied to the S-IC inner structural frames in all other areas.

S. H. Levine
S. H. Levine

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Attachment
Figures 1 - 17

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(See next page)

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Messrs. I. Davids - NASA/MAT
I. E. Day - NASA/MAT
J. H. Disher - NASA/MLD
L. E. Fero - NASA/MLV
J. P. Field - NASA/MLP
T. A. Keegan - NASA/MA-2
M. Savagh - NASA/MLT
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G. C. White, Jr. - NASA/MAR

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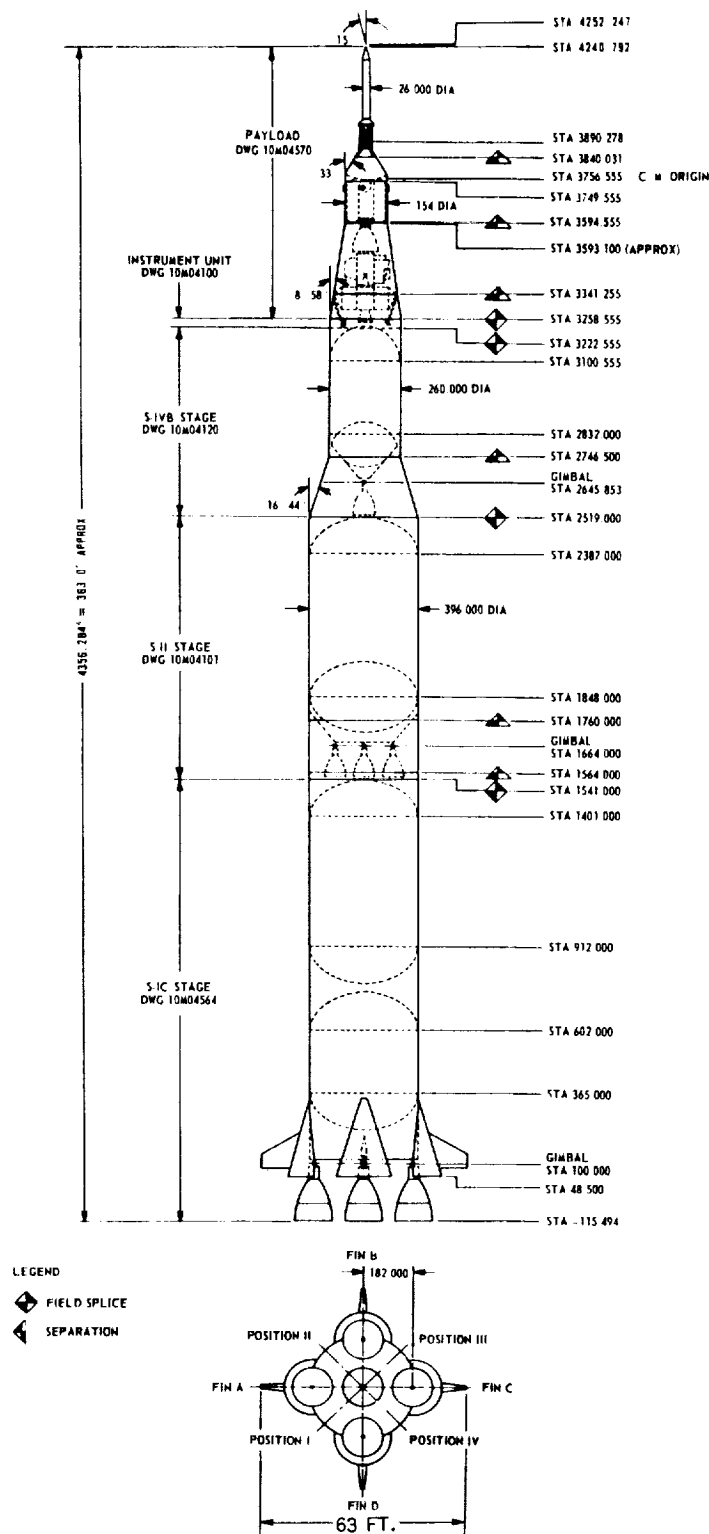


FIGURE 1 SATURN V CONFIGURATION LUNAR ORBITAL RENDEZVOUS

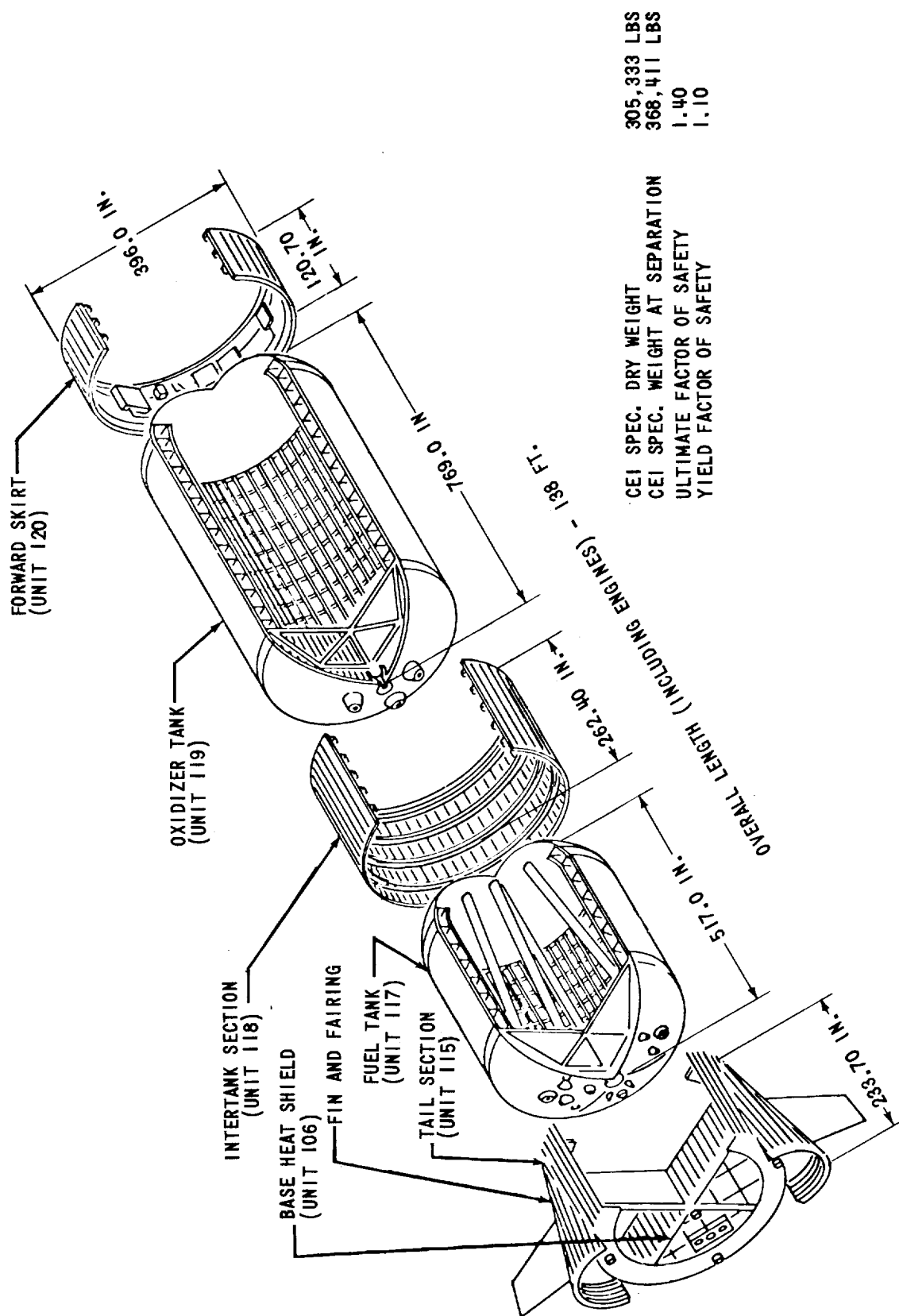


FIGURE 2 S-1C STAGE STRUCTURE

UNIT NO.	AREA DEFINITION
101	ENGINE 1 COMPARTMENT
102	ENGINE 2 COMPARTMENT
103	ENGINE 3 COMPARTMENT
104	ENGINE 4 COMPARTMENT
105	ENGINE 5 COMPARTMENT
106	BASE HEAT SHIELD
107	ENGINE FAIRING, FIN A
108	ENGINE FAIRING, FIN B
109	ENGINE FAIRING, FIN C
110	ENGINE FAIRING, FIN D
111	FIN A
112	FIN B
113	FIN C
114	FIN D
115	THRUST STRUCTURE COMPARTMENT
116	CABLE/PRESS TUNNEL AREAS
117	FUEL TANK AREA
118	INTERTANK COMPARTMENT
119	OXIDIZER TANK
120	FORWARD SKIRT AREA

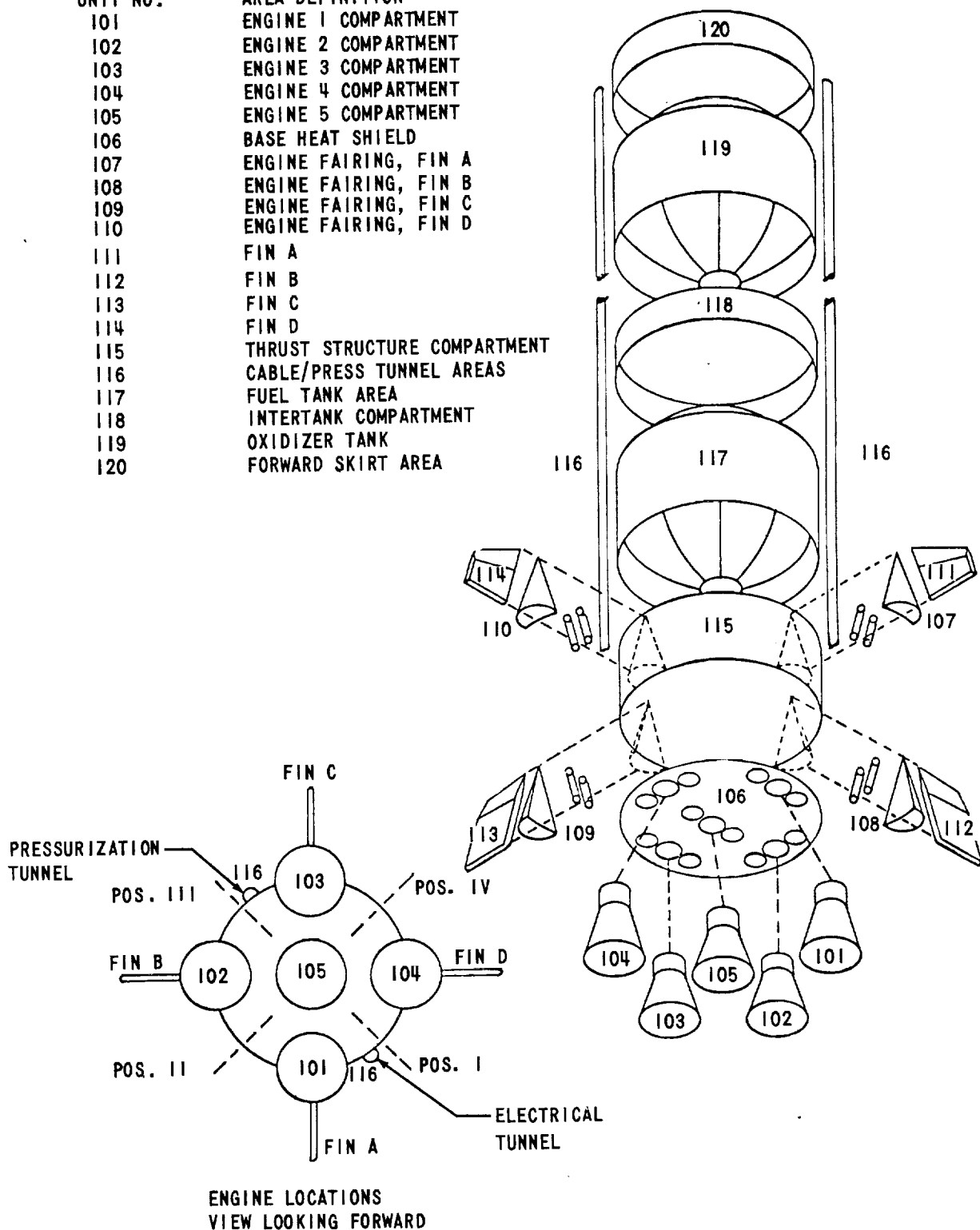


FIGURE 3 S-IC STAGE AREA DESIGNATIONS

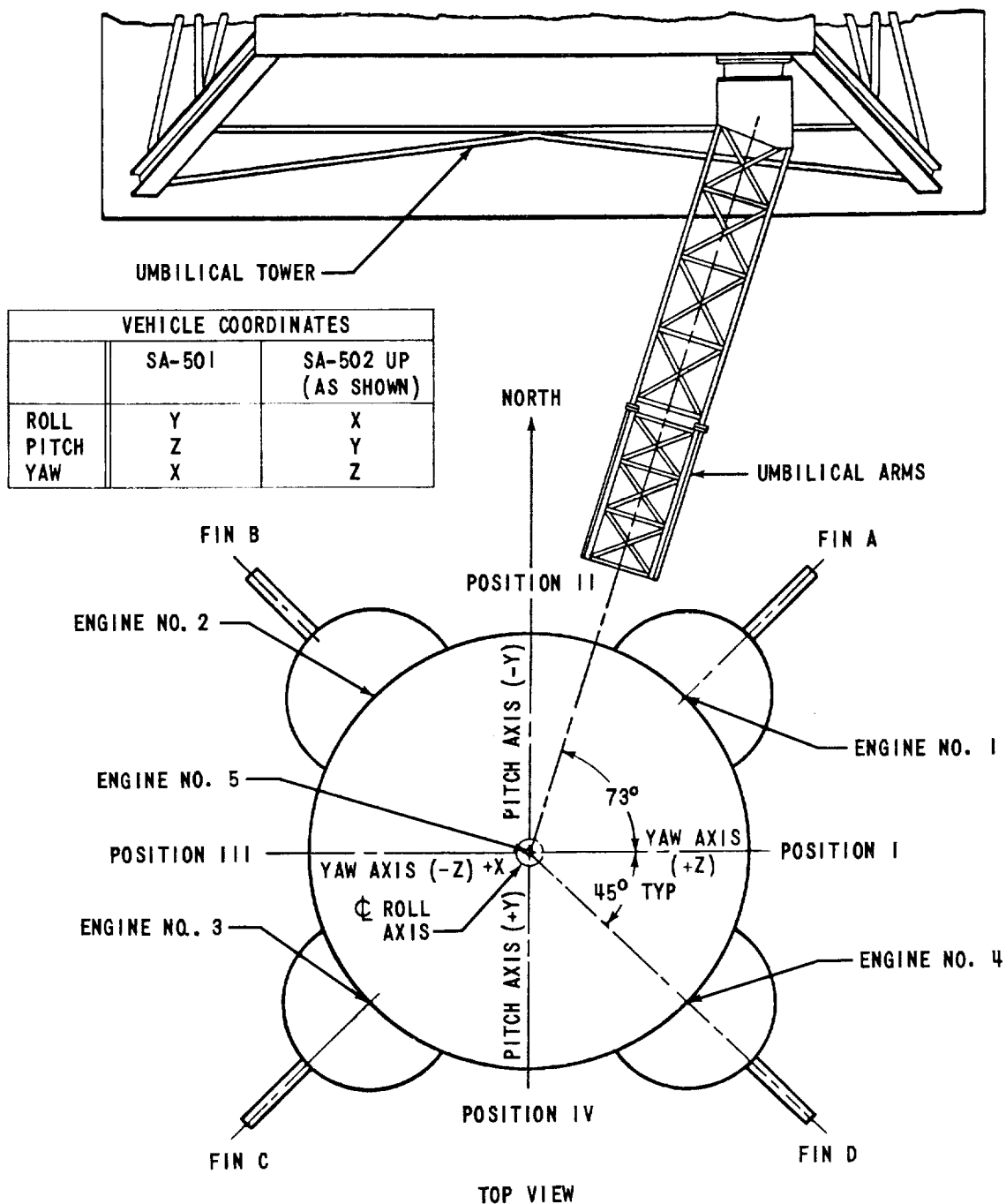


FIGURE 4 S-IC REFERENCE COORDINATES
AND RELATIONSHIP TO LAUNCH PAD

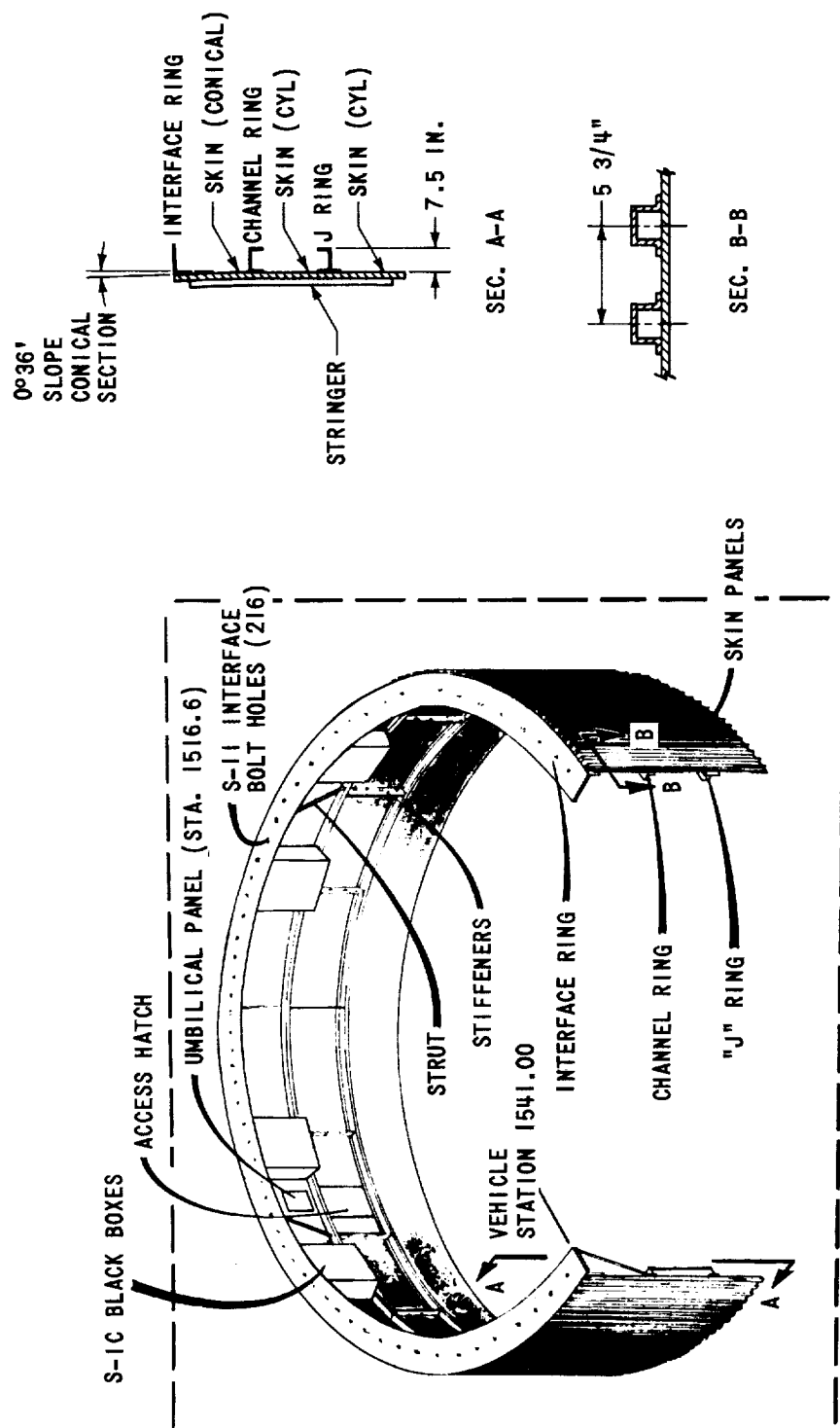


FIGURE 5 FORWARD SKIRT STRUCTURE (UNIT 120)

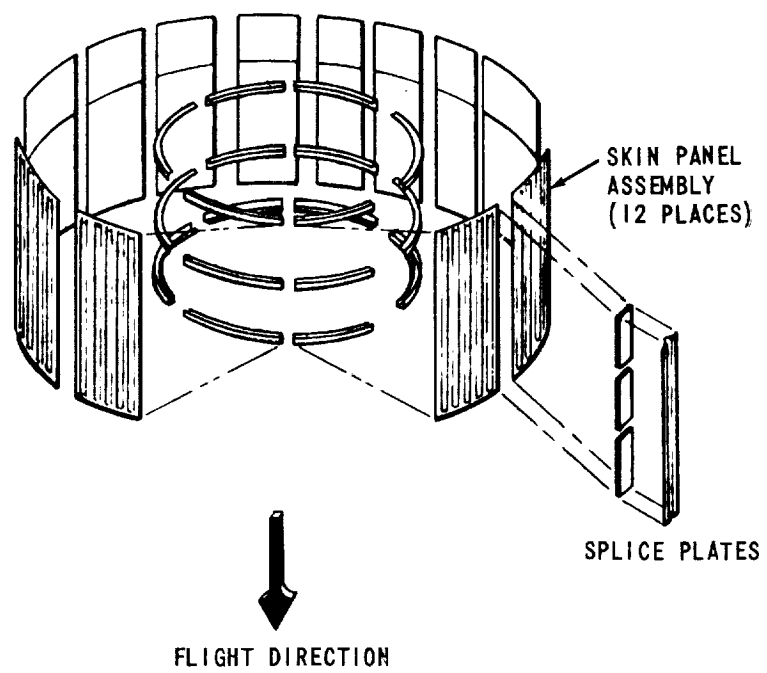


FIGURE 6 FORWARD SKIRT ASSEMBLY

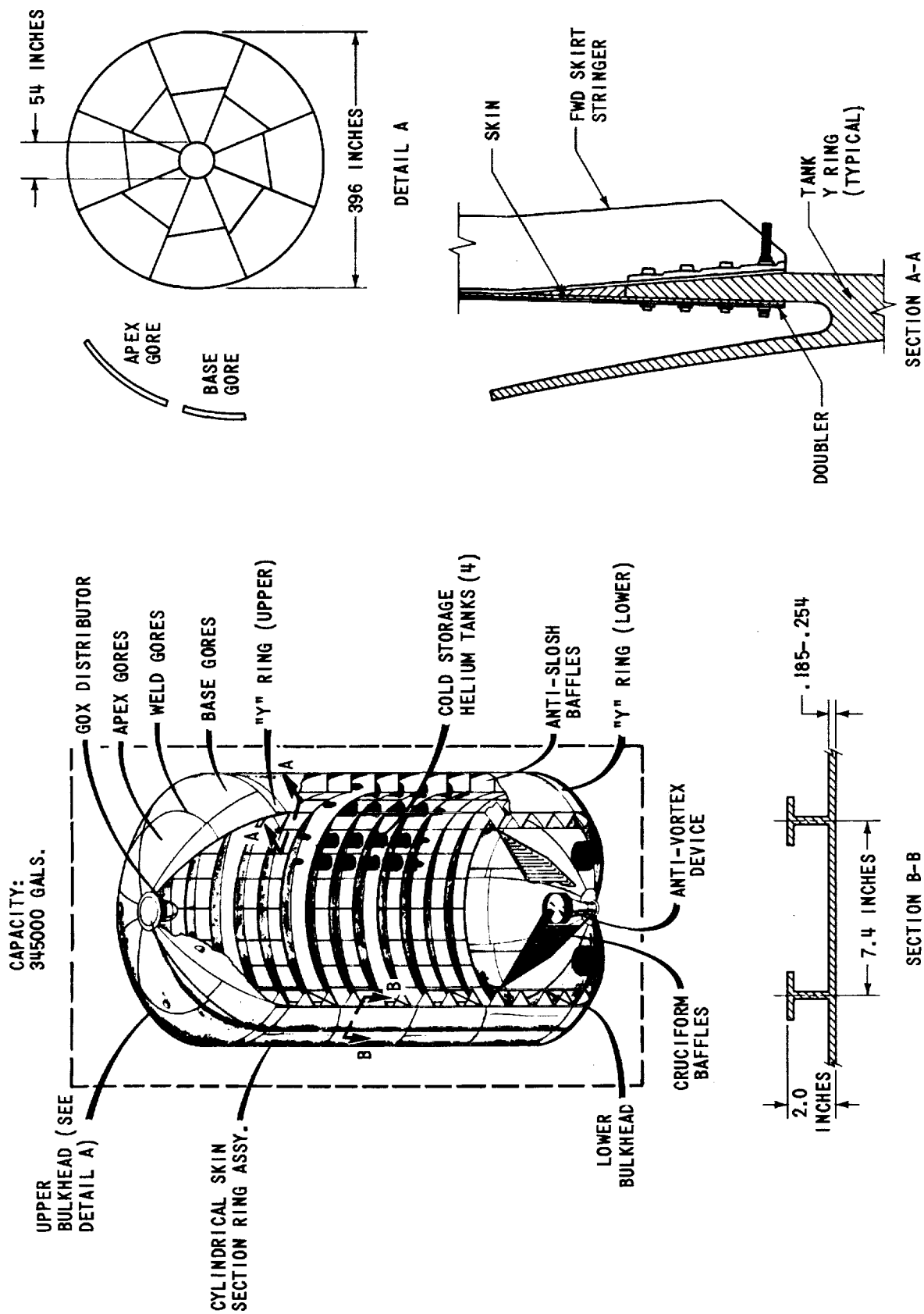


FIGURE 7 LOX TANK STRUCTURE (UNIT 119)

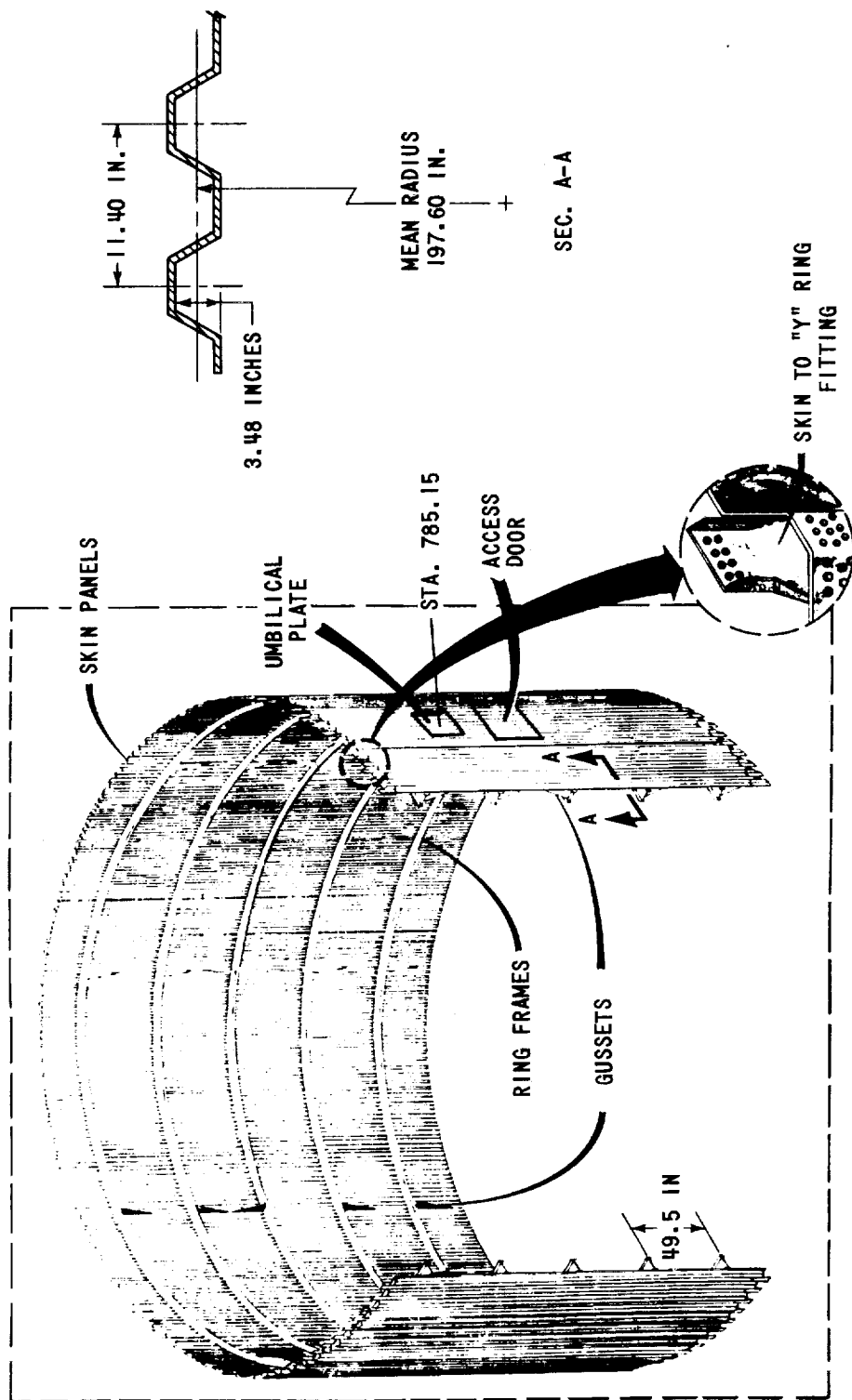


FIGURE 8 INTERTANK STRUCTURE (UNIT 118)

CAPACITY: 216,000 GALS.

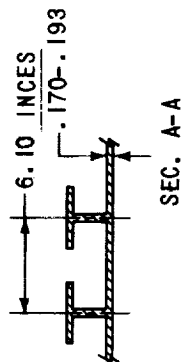
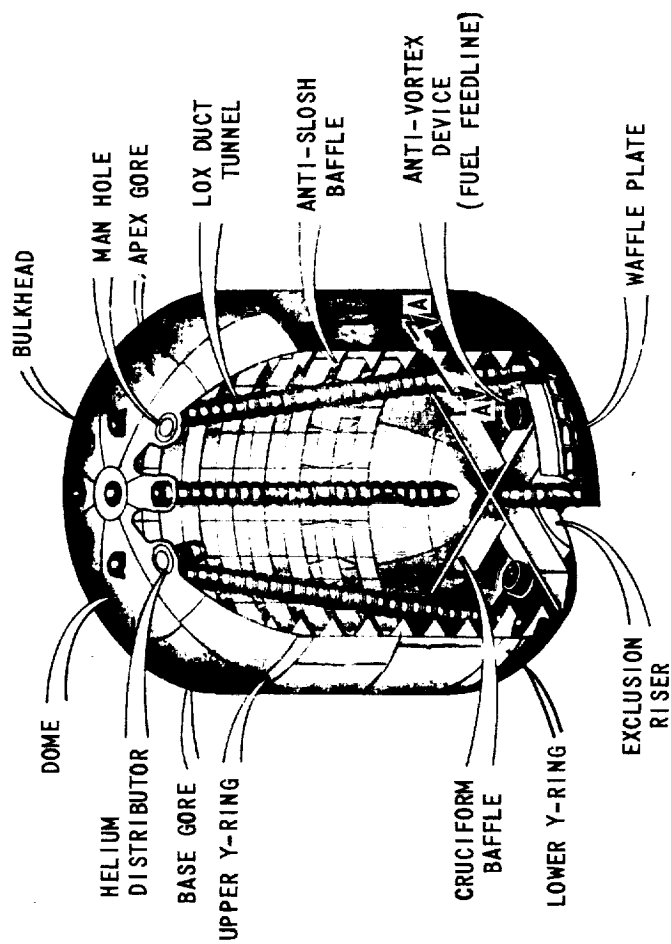


FIGURE 9 FUEL TANK STRUCTURE (UNIT 117)

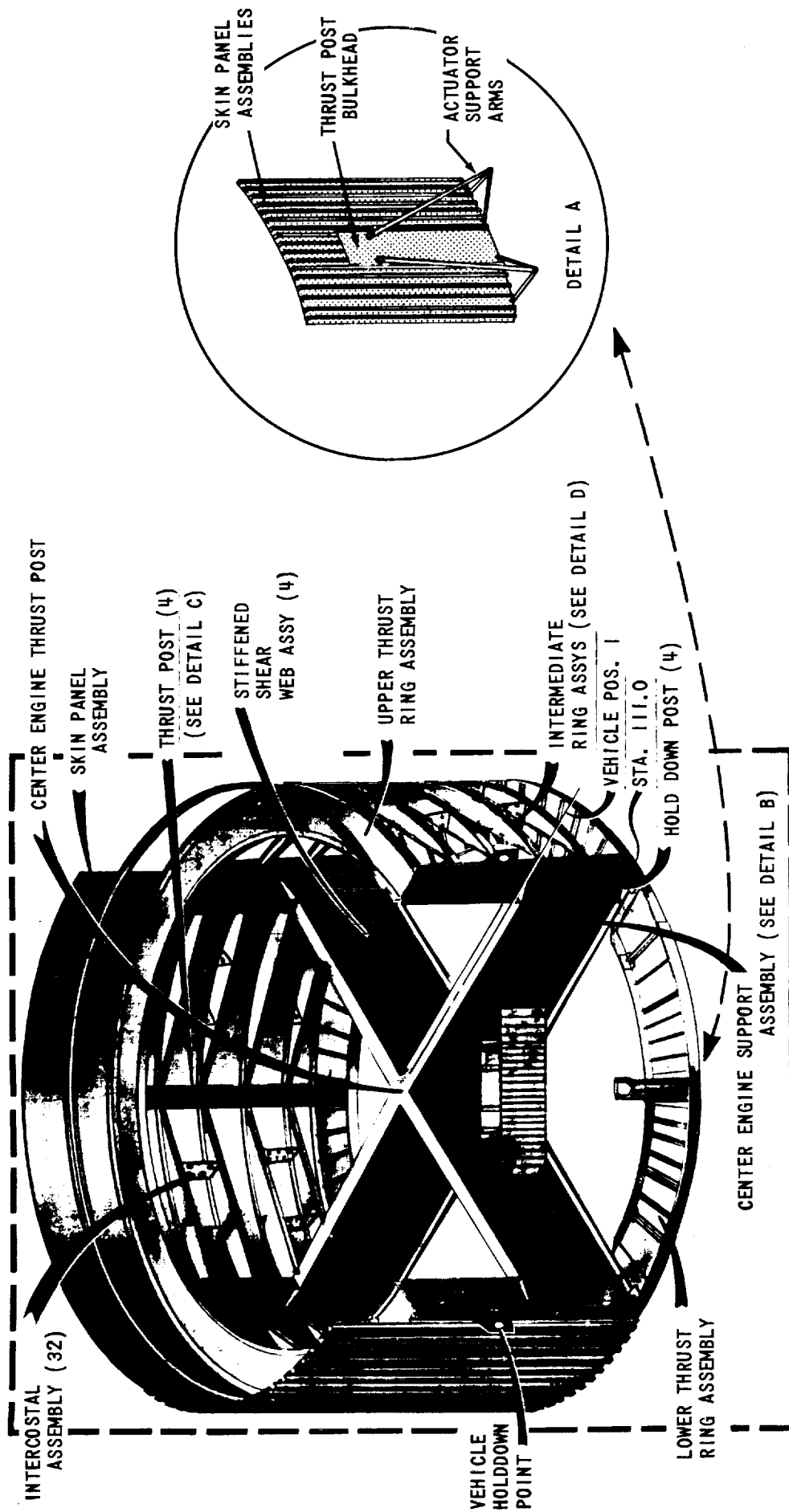


FIGURE 10 THRUST STRUCTURE (UNIT 115)

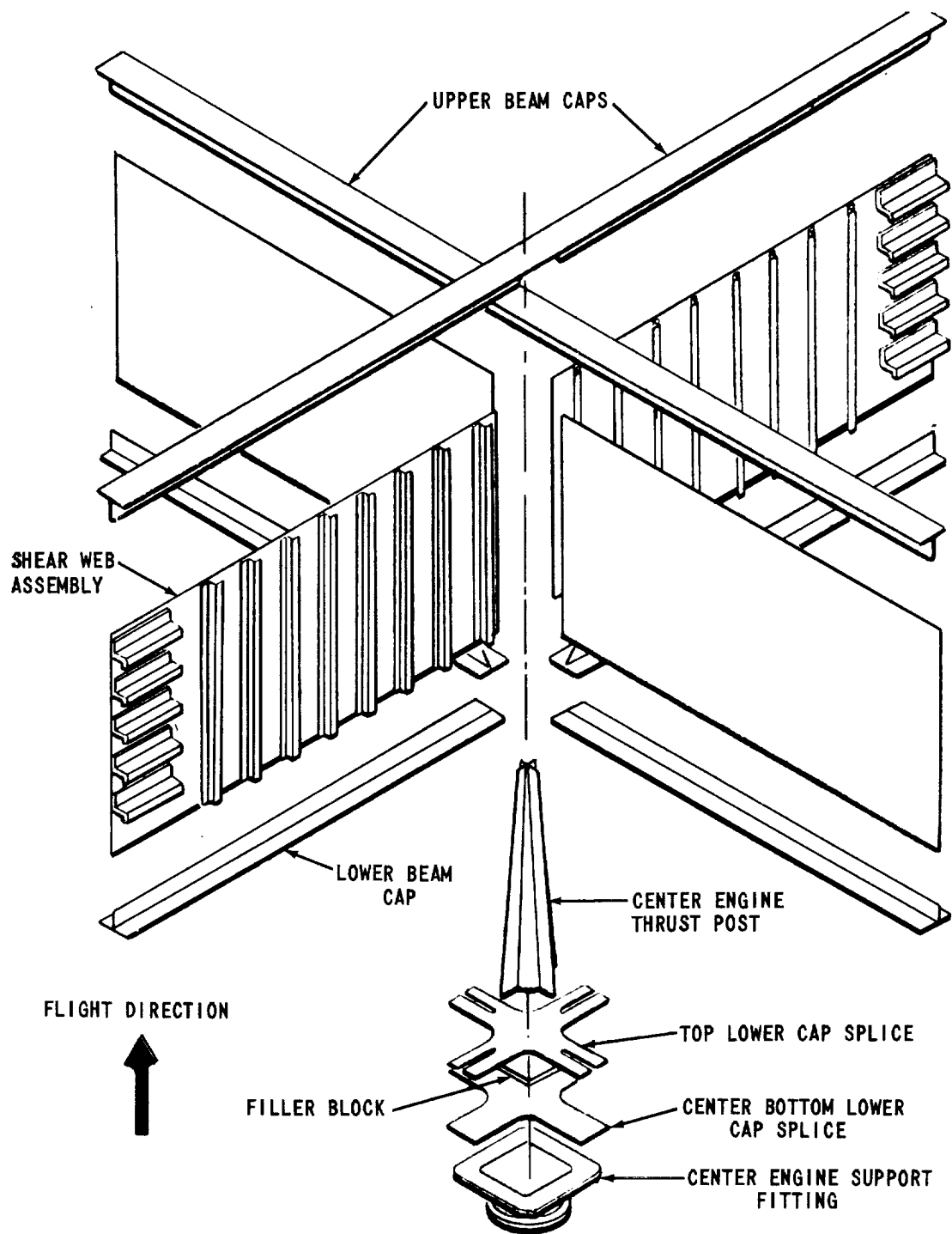


FIGURE 11 DETAIL B CENTER ENGINE SUPPORT ASSEMBLY - EXPLODED VIEW

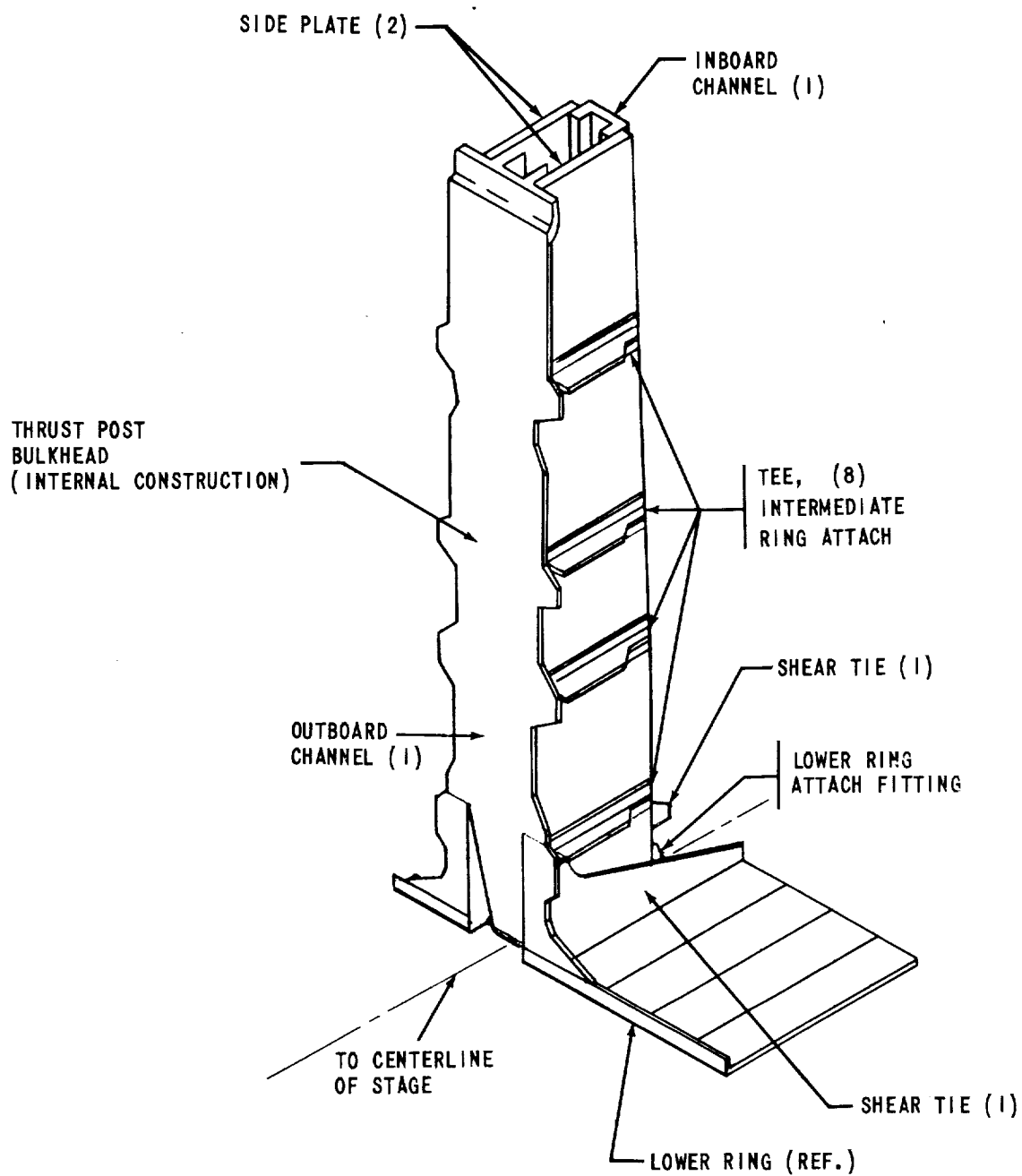


FIGURE 12 DETAIL C THRUST POST ASSEMBLY

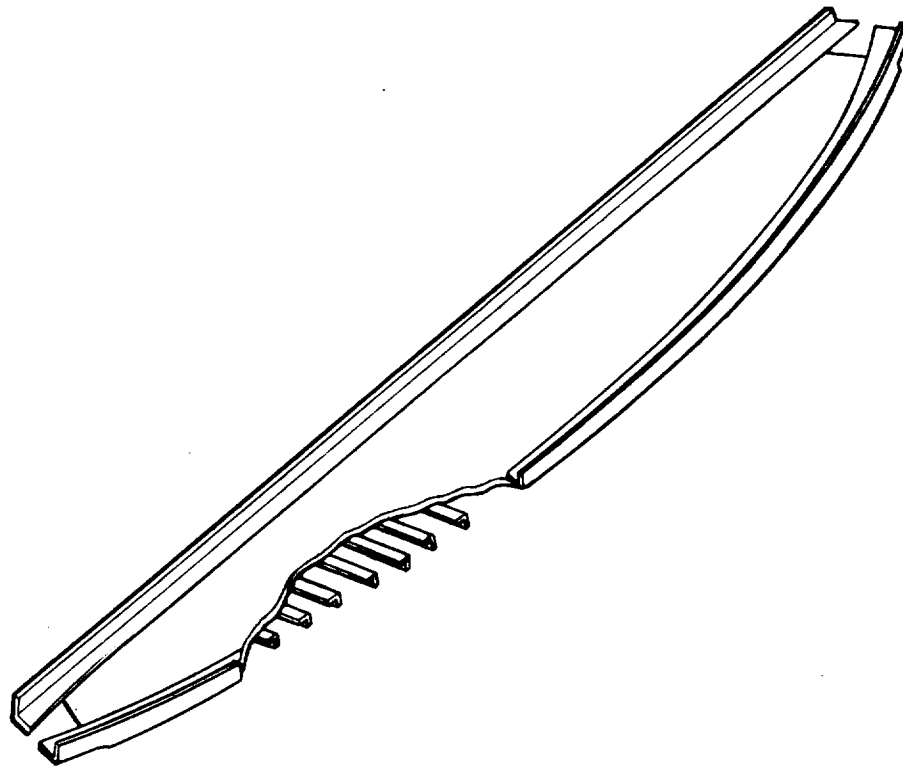


FIGURE 13 DETAIL D INTERMEDIATE RING ASSEMBLY

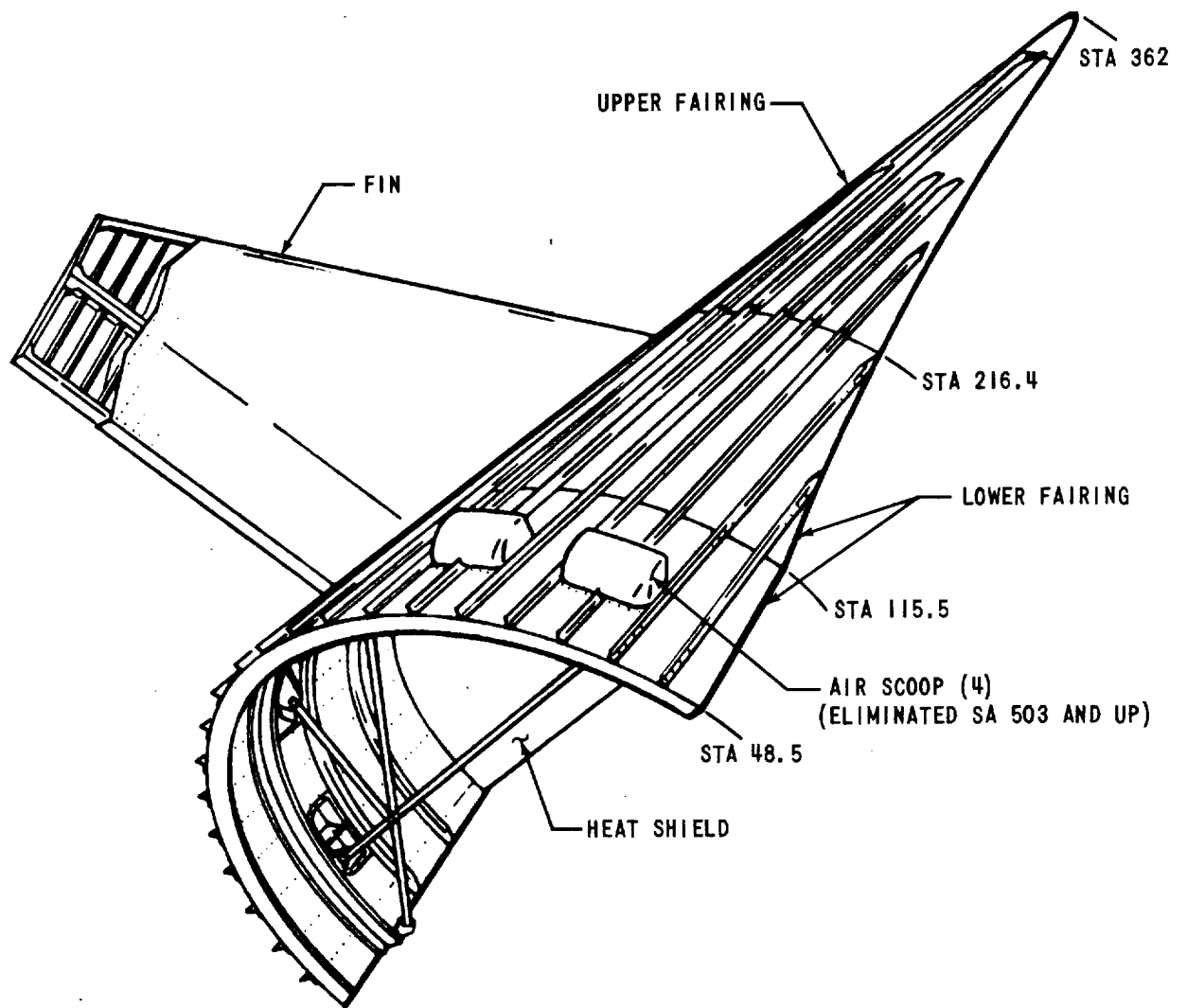


FIGURE 14 ENGINE FAIRING AND FIN

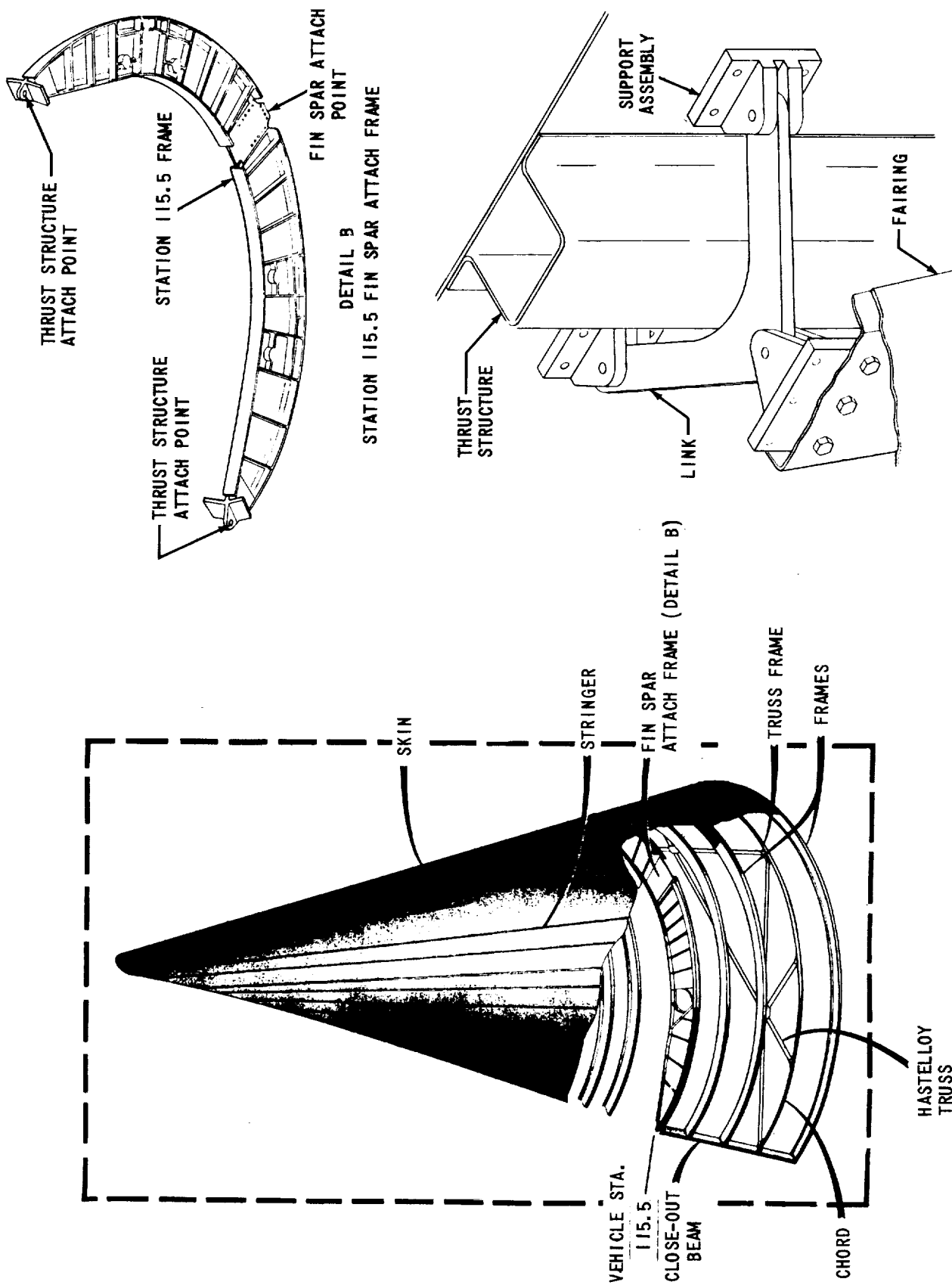


FIGURE 15 ENGINE FAIRING ASSEMBLY

PROFILE DESCRIPTION

1. LEADING EDGE RADIUS = .25"
2. 10° INCLUDED ANGLE FROM LEADING
EDGE TO MAIN SPAR
3. FLAT PLAYE FROM MAIN SPAR
TO TRAILING EDGE

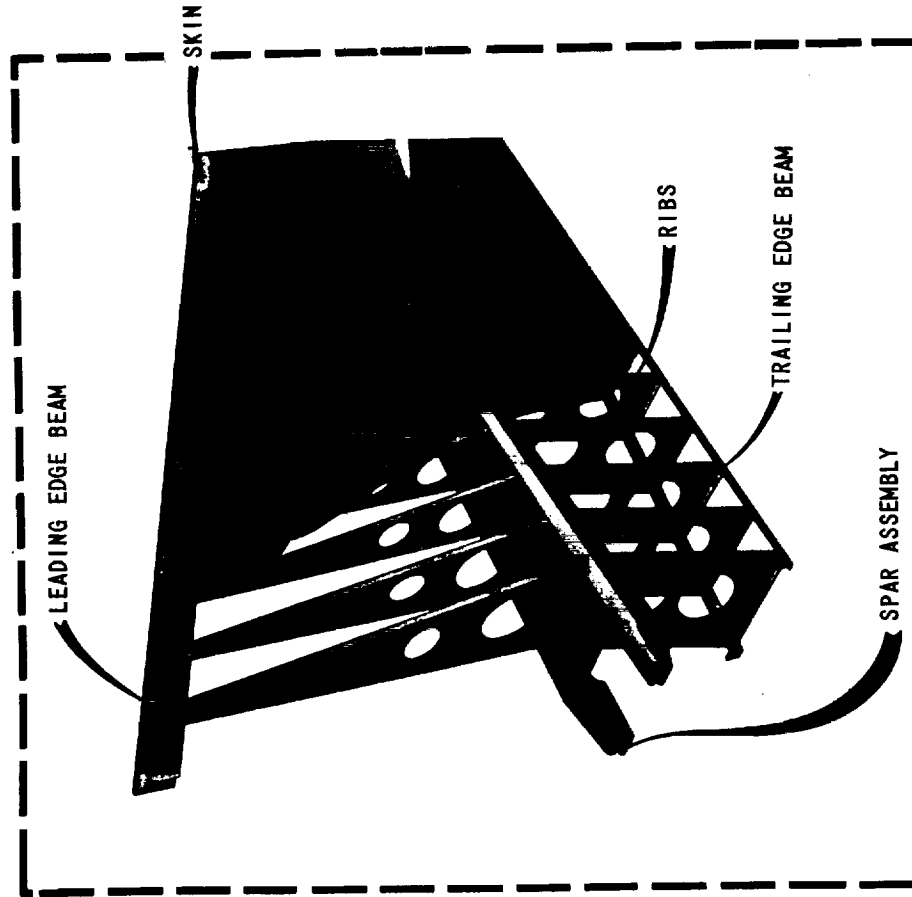
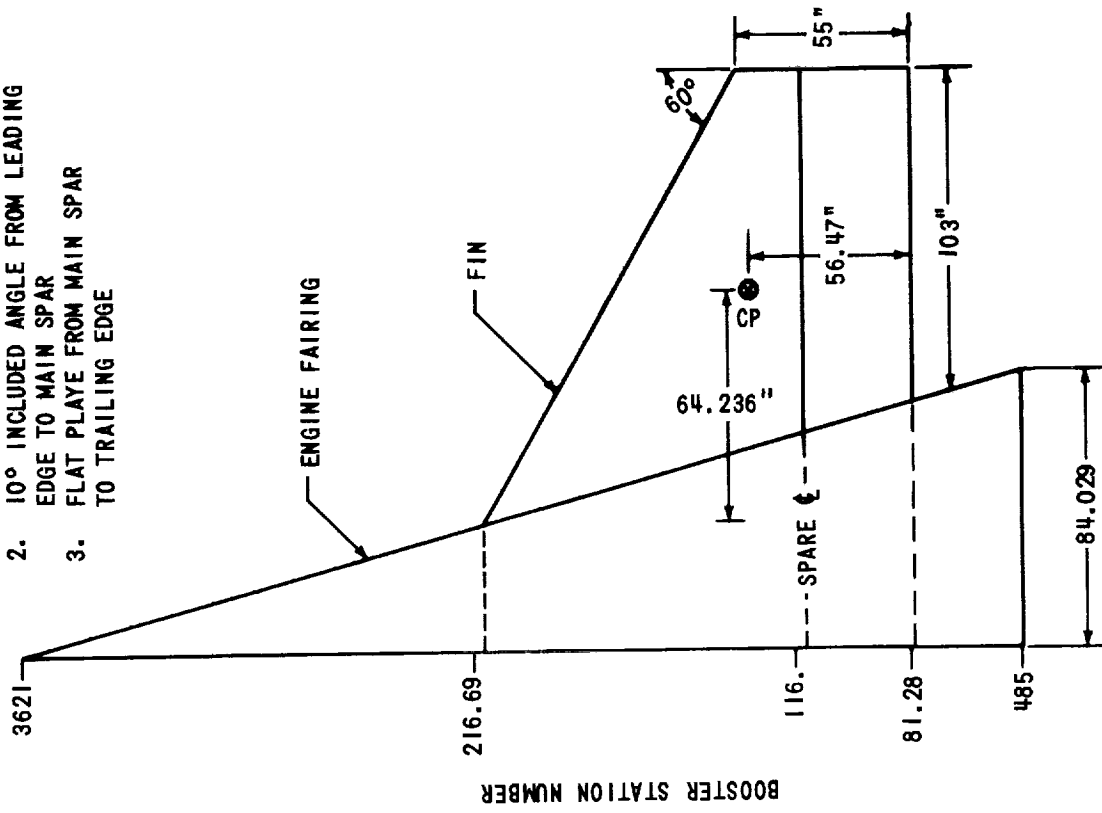


FIGURE 16 PROFILE OF FIN GEOMETRY

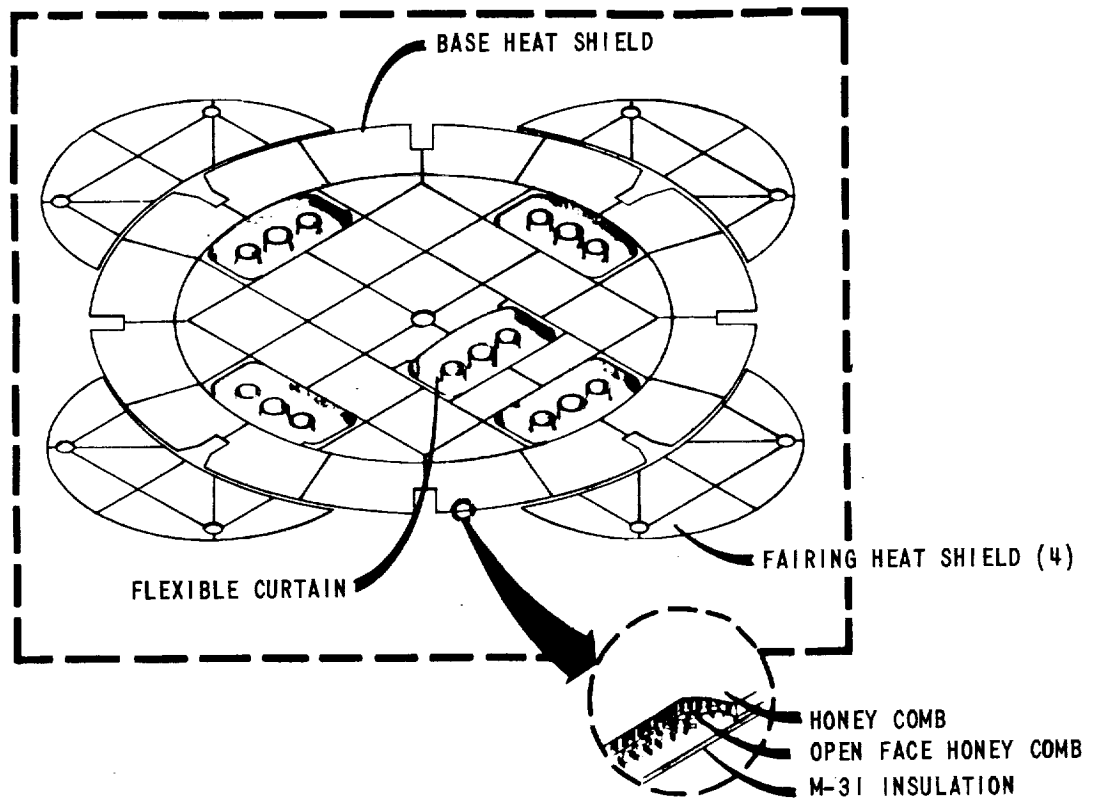


FIGURE 17 BASE AND FAIRING HEAT SHIELDS